On the Numerical Modeling of Fiber-reinforced Composites:Towards Industrial Applications

Patrice Laure, Luis Fernando Salazar Betancourt

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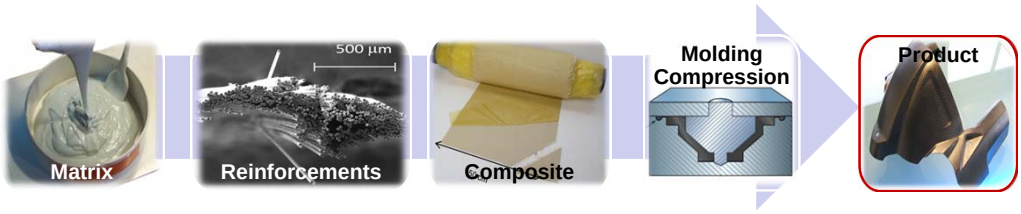
stakeholders

Process and Industrial Application

Fiber Reinforced Composites:SMC

- Motivation: Possible ways to reduce CO2 emission.
- Automotive: 10% weight reduction compared to all-aluminium design.
- Produce structural parts using fiber reinforced polymer composites:
  « Ultra Light » or « High Performance »
- SMC (Sheet Moulding Compound) process:
  4 Steps: Flat pattern insertion, Filling, Curing, Ejection.



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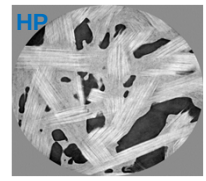
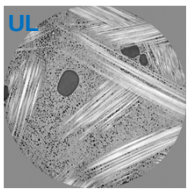
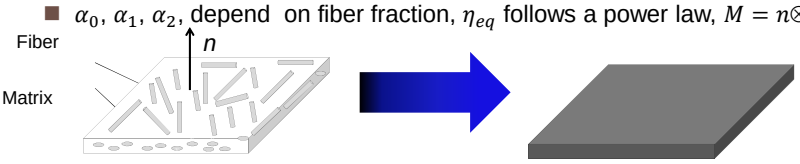




Micro-tomographies before molding

Rheological Behaviour of SMC under Compression

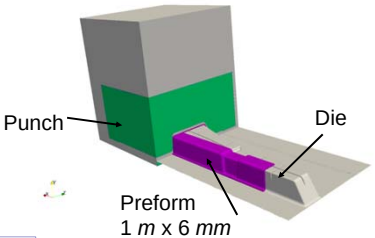
- Homogenisation: fiber and matrix are seen as a single phase
- Model of planar isotropy: fiber orientation perpendicular to vector n
- Anisotropic compressible Stokes equations coupled with thermo-kinetic equations [Dumont *et al.,* 2003],[Boyer *et al.,* 2007]
- Viscous stress Tensor: $\underline{\sigma} = \alpha_0 \eta_{eq} \left[\underline{D} + \alpha_1 \left(\underline{M} : \underline{D} \right) . \underline{M} + \frac{1}{2} \alpha_2 \left(\underline{M} . \underline{D} + \underline{D} . \underline{M} \right) \right]$,
- α_0, α_1, α_2, depend on fiber fraction, η_{eq} follows a power law, $M = n \otimes n$



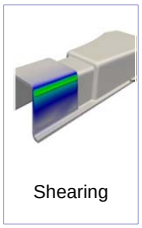
Numerical Simulations

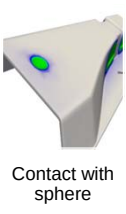
Finite Element Library fully parallelized

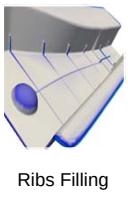
- Immersed methods and mesh adaptation.
- Interface tracking and mass conservation.
- Friction against wall, Penalty method forBoundary Conditions.

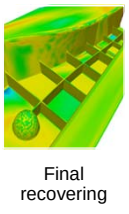



Piston Displacement


Shearing


Contact with sphere


Ribs Filling


Final recovering

Matériaux : réalités et nouvelles frontières
Mars 2016